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[Article]

Comparison of Seasonal Bluegill Catch Rates and Size Distributions Obtained with Trap Nets and Electrofishing in a Large, Heated Impoundment

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Abstract.—To determine potential bias in bluegill *Lepomis macrochirus* population indices, we compared the catch rates and size structure of bluegills captured by use of trap-netting and electrofishing from 1983 to 2001 in Coffey County Lake, a 2,100-ha cooling impoundment in Kansas. Trap-net catch per unit effort (CPUE) and size structure (proportional stock density [PSD]) were greater in 13-mm-mesh than in 25-mm-mesh trap nets, but length frequencies were similar. Bluegill electrofishing CPUE and PSD were greater during fall than spring, but longer bluegills were obtained by spring electrofishing. Trap nets produced a higher bluegill CPUE than did spring electrofishing, and the trap-net length frequency was skewed toward longer fish. Our data suggest that (1) the 13-mm trap-net mesh size yields more accurate information about harvestable-size bluegill abundance and size structure than 25-mm trap nets and (2) trap-netting (both mesh sizes combined) produces more accurate information about harvestable-size bluegill abundance and size structure than does spring electrofishing. Year effects played a large role in the differences detected among catch rates and population indices. Although fall electrofishing provided a larger bluegill sample than did spring electrofishing, size structure differences were not great enough to warrant a change in the standard electrofishing sampling period (i.e., spring) for bluegills in large Kansas impoundments because black bass *Micropterus* spp. can be sampled concurrently. This study provides gear and seasonal bias information on bluegill catch rates and size structure. Such information is lacking for large impoundments, which points to the need for further studies like ours.

Management decisions based on the size structure and abundance of bluegills *Lepomis macrochirus* are typically derived from electrofishing or trap-net samples. Both gear types have inherent biases; trap nets collect larger bluegills (Cross et al. 1995), whereas electrofishing can be selective for intermediate sizes of bluegills (Simpson 1978; Bayley and Austen 1987). In Kansas, spring electrofishing for bluegills is conducted ancillary to black bass *Micropterus* spp. sampling because of time constraints. Alternatively, bluegill populations are monitored by use of fall trap-netting that primarily targets crappies *Pomoxis* spp. However, to adequately monitor and manage these populations, management agencies and biologists must seek to identify an appropriate sampling technique and to use it as a standard method.

Although bluegills are considered a popular sport fish in small Kansas impoundments, appropriate sampling techniques for this species in both small and large impoundments do not exist. In addition, there is little information addressing appropriate sampling seasons and gear for bluegills in large impoundments. Coffey County Lake, Kansas, was recently opened to fishing (fall of 1996), and interest exists in adequately monitoring all sport fish species. Additionally, an adequate assessment of the bluegill fishery is needed to understand the predator–prey relationships between largemouth bass *M. salmoides*, the most important littoral predator, and bluegills, so that managers can make appropriate recommendations for these species. The quality and abundance of Coffey County Lake's largemouth bass fishery has declined over the past decade. This decline is of concern because a high-density largemouth bass population is beneficial for keeping small gizzard shad *Dorosoma cepedianum* numbers low, thereby al-

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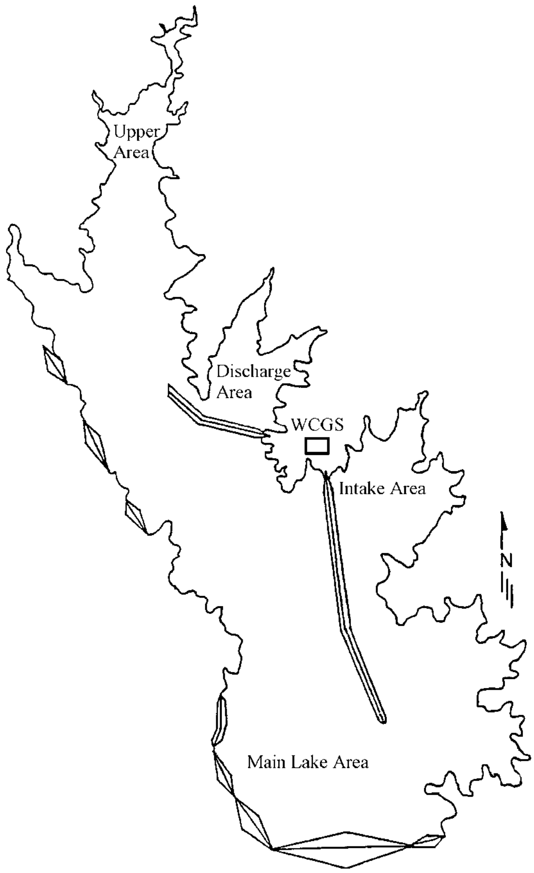

FIGURE 1.—Map of Coffey County Lake, Kansas, showing the four sampling areas where bluegills were collected by trap-netting and electrofishing. The location of Wolf Creek Generating Station (WCGS) is indicated.

leviating the risk of power plant impingement by large numbers of winter-killed gizzard shad (Haines 2000). Therefore, an accurate representation of Coffey County Lake's bluegill fishery is of interest to management biologists. Additionally, the large, consistent data set available for analysis of bluegill catch rates, population indices, and size distributions in Coffey County Lake is a rarity for large impoundments.

The purpose of our study was to evaluate differences in the catch rate, size structure (proportional stock density [PSD]), and length frequency of bluegills collected with 13- and 25-mm-mesh trap nets (spring) and electrofishing (spring and fall). Both gear types are used to sample bluegills in large Kansas impoundments, but differences in catch rate and size structure between these gear types have not been determined, and such differences may bias management decisions.

Study Site and Methods

Coffey County Lake is a 2,100-ha impoundment managed by Wolf Creek Nuclear Operating Corporation (WCNOC). The impoundment was constructed in 1982 to provide once-through cooling for Wolf Creek Generating Station, a 1,150-MW nuclear power plant in east-central Kansas. Coffey County Lake has a watershed area of 7,100 ha and averages 6.6 m in depth. Two dikes (3.6 km total) disperse water discharged through the power plant to maximize cooling efficiency (Figure 1). The lake was closed to fishing until the fall of 1996.

Four fixed locations in Coffey County Lake (upper, main lake, water intake, and discharge areas; Figure 1) have been consistently sampled during spring (April–May) and fall (September–October) since 1983. Four trap nets (1.2-m $\times$ 1.5-m frames with 1.2-m $\times$ 5.2-m leads; either 13- or 25-mm bar-measure mesh; two nets of each mesh size) were set at each location during April. A Smith-Root boat-mounted electroshocker, which operated at approximately 10 A and 220-V pulsed DC, was used to sample the four locations during daytime in May and September–October. Two replicate 15-min samples were collected at each location. All bluegills were measured (total length; mm) and weighed (g). Size structure was indexed with PSD, which was calculated as 100 times the number of quality-length fish ($\geq$150 mm) divided by the number of stock-length fish ($\geq$80 mm) (Anderson 1976). Catch per unit effort (CPUE) was quantified as the number of stock-length and larger bluegills captured per trap-net night or per 15-min electrofishing sample. The catch rate and PSD at each location were computed for each sampling method and year. The PSD values were transformed with the arcsine transformation for proportions, and CPUE values were $\log_{10}(x + 1)$ transformed prior to analyses to better meet the assumption of normality.

A split-plot analysis of variance (ANOVA) design for repeated measures (Maceina et al. 1994) was used to detect differences in the catch rate and size indices among gear types and between seasons. Variation in bluegill CPUE and PSD was partitioned by year, station, gear type, season, and interaction terms. Length frequencies were compared with the Kolmogorov–Smirnov (KS) test; a significance level α of 0.05 was established a priori for all tests.

Results

Trap Nets

Trap-net CPUE ranged from 0 to 25 bluegills per trap-net night (mean = 2.01; SD = 4.37) for

TABLE 1.—Mean catch per unit effort (SEs in parentheses) of stock-length bluegills (≥80 mm total length) collected in spring trap nets (number per trap-net night) and during spring and fall electrofishing (number per 15-min sample) in Coffey County Lake, Kansas. Spring trap-netting was discontinued in 2000; sampling was not conducted during fall 2001.

	Trap-netting		Electrofishing	
Year	13-mm mesh	25-mm mesh	Spring	Fall
1983	8.75 (3.25)	21.75 (4.25)	0.27 (0.24)	0.38 (0.35)
1984	11.50 (10.26)	9.50 (5.62)	0.61 (0.16)	0.10 (0.02)
1985	1.63 (1.31)	1.00 (0.84)	1.08 (0.37)	0.68 (0.28)
1986	0.75 (0.75)	1.75 (0.52)	0.88 (0.29)	0.21 (0.06)
1987	2.13 (1.96)	0.63 (0.24)	0.23 (0.06)	3.24 (1.33)
1988	2.38 (1.89)	1.50 (1.34)	0.20 (0.11)	1.47 (0.29)
1989	0.38 (0.24)	0.25 (0.14)	0.30 (0.08)	1.05 (0.54)
1990	0.13 (0.13)	0.0 (0.0)	0.02 (0.02)	0.89 (0.40)
1991	0.88 (0.43)	0.13 (0.13)	0.22 (0.07)	0.66 (0.23)
1992	2.25 (1.11)	0.38 (0.24)	0.19 (0.10)	0.56 (0.18)
1993	1.25 (0.72)	0.0 (0.0)	0.23 (0.08)	1.10 (0.39)
1994	1.25 (0.75)	0.25 (0.25)	0.10 (0.04)	0.77 (0.32)
1995	0.0 (0.0)	0.0 (0.0)	0.09 (0.03)	0.36 (0.08)
1996	0.0 (0.0)	0.25 (0.25)	0.06 (0.02)	0.19 (0.12)
1997	0.25 (0.25)	0.0 (0.0)	0.08 (0.04)	0.30 (0.08)
1998	0.13 (0.13)	0.0 (0.0)	0.12 (0.03)	0.65 (0.11)
1999	0.25 (0.14)	0.0 (0.0)	0.08 (0.03)	1.04 (0.36)
2000			0.27 (0.05)	0.44 (0.12)
2001			0.14 (0.03)	

the 13-mm-mesh nets and from 0 to 22 bluegills per trap-net night (mean = 1.15; SD = 3.31) for the 25-mm-mesh nets. Mean CPUE differed among years (F = 18.36; df = 1, 16; P < 0.0001) and between gear types (F = 9.41; df = 1, 16; P = 0.004) (Table 1). Additionally, the year × gear type interaction was significant (F = 2.55; df = 1, 16; P = 0.01). The mean PSD was 33 (SD = 45) for the 13-mm-mesh trap nets and 31 (SD = 45) for the 25-mm-mesh trap nets. Mean PSD differed among years (F = 3.64; df = 1, 16; P = 0.001) but not between gear types (F = 0.74; df = 1, 16; P = 0.40). Interaction terms were not significant (F = 1.04; df = 1, 16; P = 0.44) between the trap-net mesh sizes. Length frequencies of stock-length bluegills were similar between the two mesh sizes (asymptotic KS statistic [KSa] = 0.85; df = 425; P = 0.47) (Figure 2). Catch from the two trap-net mesh sizes was pooled because of the similarity in PSD and fish length, and to allow comparison of trap-net and electrofishing catch rates.

Electrofishing

The spring electrofishing CPUE ranged from 0 to 2.1 bluegills per 15-min sampling period (mean = 0.3; SD = 0.35) (Table 1). Fall electrofishing CPUE was more variable and ranged from 0.03 to

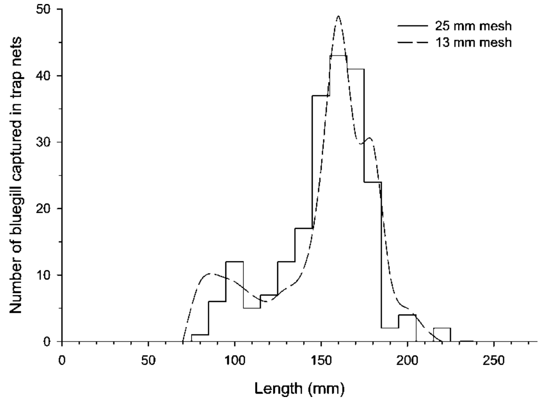

FIGURE 2.—Length frequencies of bluegills captured with 13- and 25-mm-mesh trap nets set in Coffey County Lake, Kansas, during spring (1983–2001).

5.7 bluegills per 15-min sampling period (mean = 0.7; SD = 0.86). The electrofishing CPUE differed among years (F = 2.77; df = 1, 18; P = 0.001) and between seasons (F = 26.36; df = 1, 18; P < 0.0001) (Table 1). Additionally, the year × season interaction was significant (F = 3.16; df = 1, 18; P = 0.0004). The mean PSD was 29 (SD = 31) for spring electrofishing and 17 (SD = 24) for fall electrofishing. Year effects were not apparent (F = 1.57; df = 1, 18; P = 0.10), but mean PSD values were greater in the spring than in the fall (F = 4.62; df = 1, 18; P = 0.04). Interaction terms were not significant (F = 1.30; df = 1, 18; P = 0.22). Bluegill length was greater in the spring samples than in fall samples (KSa = 6.05; df = 2,279; P < 0.0001) (Figure 3).

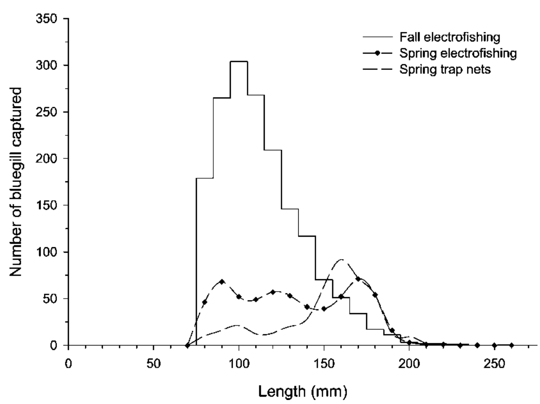

FIGURE 3.—Length frequencies of bluegills captured with spring trap nets, spring electrofishing, and fall electrofishing in Coffey County Lake, Kansas (1983–2001).

Spring Electrofishing and Spring Trap Nets

The CPUE for spring electrofishing and spring trap nets was not compared because catch rates were not standardized to number per person-hour. Mean PSD values were 29 (SD = 31) for spring electrofishing and 69 (SD = 42) for trap nets. The PSD differed among years ($F = 2.12$; df = 1, 18; $P = 0.03$) and gear types ($F = 8.82$; df = 1, 18; $P = 0.006$). Interaction terms were not significant ($F = 0.89$; df = 1, 18; $P = 0.58$). The length of captured bluegills was greater in the trap nets than in electrofishing samples (KSa = 5.22; df = 1,028; $P < 0.0001$) (Figure 3).

Discussion

Electrofishing is a widely used method of sampling bluegill populations (Kruse 1991). Although Simpson (1978) showed that electrofishing is selective toward 75–150-mm fish, Reynolds and Simpson (1978) failed to show size selectivity. Bayley and Austen (1987) demonstrated that AC electrofishing was most efficient in capturing intermediate-size bluegills (100–150 mm). Bayley and Austen (1987) also reported that bluegill length, percent vegetative cover, and mean depth of the sampling area explained 73% of the variation in sampling efficiency. Kosa and Hale (2000) found that bluegill electrofishing catch rates in small Kentucky impoundments were highly variable; catch rates peaked in April (coinciding with the peak catch of largemouth bass) and declined through June. Their study indicated peak abundances of bluegills during April. Bettross and Willis (1988) showed that bluegill CPUE obtained with AC electrofishing peaked in May and September, and that PSD peaked in May and declined throughout the rest of the sampling season. In our study, yearly differences were readily apparent in PSD comparisons between most combinations of gear type and season. As Coffey County Lake has aged, bluegill catch rates have declined (Table 1) (Kimmel and Groeger 1986), which likely also influences the observed yearly differences in catch rates.

Trap nets are size selective toward bluegills (Kruse 1991). Laarman and Ryckman (1982) showed that trap nets were selective toward larger bluegills. Hamley and Howley (1985) reported that the greatest catches of bluegills were obtained in trap nets set during late summer and fall. Cross et al. (1995) found that seasonal (i.e., day of year) variation explained a large percentage of the variation in bluegill biomass and CPUE in trap nets set in Minnesota; the size and CPUE of bluegills declined from June through August. Jackson and Bauer (2000) determined that 13-mm-mesh trap nets caught more substock-size bluegills than 16-mm-mesh nets, whereas the 16-mm-mesh nets caught more stock-size bluegills. The PSD values in that study were similar between gear types, but the relative stock density of preferred-length fish differed; the authors attributed the difference to small sample sizes (Jackson and Bauer 2000). In our study, the smaller-mesh (13 mm) trap nets caught more stock-size bluegills than the larger-mesh (25 mm) trap nets. The year effect played a large role in these differences, however.

Kruse (1993) reported that trap-net PSD during fall sampling was higher than electrofishing PSD and suggested that trap nets were more efficient than electrofishing at capturing larger bluegills. Our comparison of spring trap-net and electrofishing samples indicated that the PSD values were similar between these gear types. However, we also found that spring trap nets were selective toward larger ($\geq$150 mm) bluegills, similar to findings by other authors (Bettross and Willis 1988; Kruse 1993; Cross et al. 1995). These size differences may reflect the fact that trap nets are often set away from littoral cover, which may provide protection for smaller bluegills. Therefore, as an active sampling gear, electrofishing can be used in a greater variety of habitats, including those that conceal smaller fish.

In Coffey County Lake, the bluegill catch rate, PSD, and length frequency during spring were all greater for trap-netting than for electrofishing. Therefore, trap nets may be better predictors of harvestable-size bluegills in large impoundments. Unfortunately, bluegill evaluations in large impoundments have not been previously described in published studies. Further studies similar to ours are warranted for agencies that manage popular bluegill fisheries in larger impoundments, and can be used to better describe prey availability to littoral predators in large impoundments. Our recommendations are similar to those proposed by Kruse (1993) for small impoundments; spring electrofishing is more useful because this method will also sample largemouth bass, and conforms to the recommended sampling period and technique for bluegills in large Kansas impoundments. Electrofishing catch rates of centrarchids in large Kansas reservoirs are generally not high enough to hinder collection of nearly all stunned fish. Kosa and Hale (2000) were able to accurately sample both bluegills and largemouth bass concurrently, but their study design targeted each species specifically by collecting only largemouth bass or only bluegills during alternating samples. In other large impoundments, however, catch rates may be higher; in these systems, differences in bluegill catch rate and size structure between spring electrofishing and fall trap-netting should be evaluated to determine the best gear and season for bluegill sampling.

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